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Record of Jurassic mass transport processes through the orogenic cycle: Understanding chaotic rock units in the high-pressure Zermatt-Saas ophiolite (Western Alps)

Paola Tartarotti[1,*], Andrea Festa[2], Luca Benciolini[3], and Gianni Balestro[2]
[1]DIPARTIMENTO DI SCIENZE DELLA TERRA, UNIVERSITÀ DI MILANO, VIA MANGIAGALLI, 34, 20133 MILANO, ITALY
[2]DIPARTIMENTO DI SCIENZE DELLA TERRA, UNIVERSITÀ DI TORINO, VIA VALPERGA CALUSO, 35, 10125 TORINO, ITALY
[3]DIPARTIMENTO DI SCIENZE AGROALIMENTARI, AMBIENTALI E ANIMALI, UNIVERSITÀ DI UDINE, VIA DEL COTONIFICIO, 114, 33100 UDINE, ITALY

ABSTRACT

The eclogite facies Zermatt-Saas ophiolite in the Western Alps includes a composite chaotic unit exposed in the Lake Miserin area, in the southern Aosta Valley region. The chaotic unit is characterized by a block-in-matrix texture consisting of ultramafic clasts and blocks embedded within a carbonate matrix. This unit overlies massive serpentinite and ophicarbonate rocks and is unconformably overlain by layered calcschist. Despite the effects of subduction and collision-related deformation and metamorphism, the internal stratigraphy and architecture of the chaotic unit are recognizable and are attributed to different types of mass transport processes in the Jurassic Ligurian-Piedmont Ocean. This finding represents an exceptional record of the preorogenic history of the Alpine ophiolites, marked by different pulses of extensional tectonics responsible for the rough seafloor topography characterized by structural highs exposed to submarine erosion. The Jurassic tectonostratigraphic setting envisioned is comparable to that observed in present-day magma-poor slow- and ultraslow-spreading ridges, characterized by mantle exposure along fault scarps that trigger mass transport deposits and turbiditic sedimentation. Our preorogenic reconstruction is significant in an eclogitized collisional orogenic belt in which chaotic rock units may be confused with the exclusive product of subduction-related tectonics, thus obscuring the record of an important preorogenic history.

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INTRODUCTION

In most orogenic belts, the temporal and spatial distributions of different types of mass transport deposits (MTDs) commonly document different tectonic stages within the Wilson cycle evolution of oceanic basins, from the early stages of rift drift to later subduction, collision, and orogenic exhumation (Festa et al., 2016, and references therein). MTDs therefore represent fundamental markers of most of the tectonic events, and the documentation and understanding of their overall architecture, internal fabric, composition, and mechanisms of their downslope deformation and emplacement are relevant for better understanding the characteristics of depositional basins and the evolution of orogenic belts. However, in most orogenic belts and exhumed subduction-accretion complexes, a strong similitude of fabric exists between MTDs with a block-in-matrix fabric (i.e., olistostrome sensu Flores, 1955; sedimentary mélanges, e.g., see Raymond, 1984) and tectonic mélanges (e.g., Hsü, 1974; Raymond, 1984; Cowan, 1985; Bettelli and Panini, 1989; Pini, 1999; Festa et al., 2010, 2013; Dilek et al., 2012; Alonso et al., 2015; Balestro et al., 2015b; Platt, 2015; Wakabayashi, 2015). This similitude is the basis of a long-lasting debate on the processes of formation of chaotic rock units (i.e., tectonic versus gravitational), and is strongly amplified in metamorphic belts, where polyphase deformation and metamorphic recrystallization to eclogitic conditions commonly rework and obscure the primary internal structure of chaotic rock units.

In the metaophiolite units of the Western Alps, different methodological approaches (e.g., structural, petrographic, stratigraphic) adopted in the interpretation of the nature of chaotic rock units and mélanges led to the definition of different tectonic models, which are still debated. For example, mélanges consisting of mafic blocks tectonically incorporated in a serpentinite matrix (i.e., the serpentinite mélange) were described by Guillot et al. (2004) and Federico et al. (2007) as remnants of an exhumed subduction channel (see also Blake and Jayko, 1990; Gerya et al., 2002; Guillot et al., 2009). However, tectonostratigraphic approaches interpreted the western Alpine ophiolitic mélanges as the product of inherited intraoceanic deformation (Balestro et al., 2015a; Lagabrielle et al., 2015), despite the reworking by Alpine subduction- and exhumation-related deformation. This has allowed the documentation of details on the preorogenic evolution of the high-pressure (HP) western Alpine metaophiolites, describing the exhumation of mantle rocks at the seafloor, the formation of chaotic rock units linked with oceanic detachment faults, and the emplacement of basaltic and sedimentary succession with strong lateral and vertical variations (e.g., Tricart and Lemoine, 1991; Festa et al., 2015a; Lagabrielle et al., 2015, and references therein). These different models may, however, not represent contrasting interpretations, but only different stages of a complex evolution from intraoceanic deformation to subduction and subsequent collision.

The application of the proper criteria to the study of mélange rock units together with detailed structural and stratigraphic analyses may provide

Paola Tartarotti http://orcid.org/0000-0002-2236-2702
*Email: paola.tartarotti@unimi.it

